(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 002 951 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.05.2000 Bulletin 2000/21

(51) Int Cl.[7]: **F04B 39/10**, F16K 15/16

(21) Application number: **99308362.5**

(22) Date of filing: **22.10.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **20.11.1998 GB 9825550**

(71) Applicant: **Arctic Circle Limited**
Hereford HR2 6JL (GB)

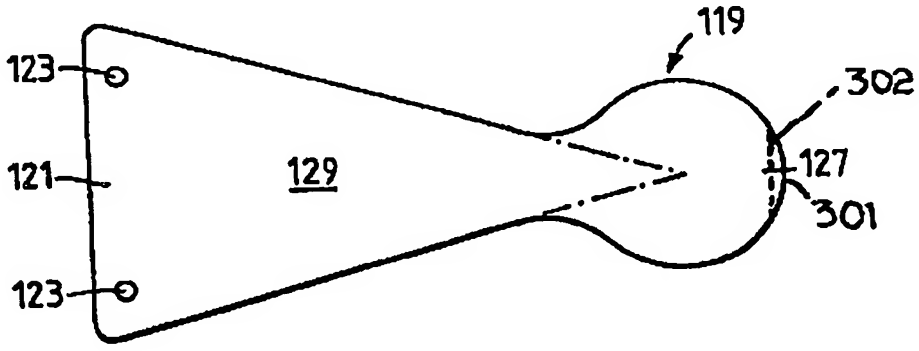
(72) Inventor: **Lawson, Stuart**
Thatcham, Berkshire RG18 3BH (GB)

(74) Representative: **Jones, Graham H.**
Graham Jones & Company
Blackheath
77 Beaconsfield Road
London SE3 7LG (GB)

(54) A reed for use in a valve assembly

(57) A reed (119) for use in a valve assembly, the reed being an elongate resilient reed (119) which comprises a body portion (129) having one end (121) intended for fixing to a mount and another end contiguous with a valve closure portion (127) of the reed (119), the reed (119) being such that the width of the body portion (129) tapers towards the valve closure portion (127) so that the width of the surface of the body portion (129) adjacent the valve closure portion (127) is small relative to the width of the valve closure portion (127) whereby the configuration of the reed (119) is such as substantially to equalise the bending stress experienced by the reed (119) along the length of the body portion (129) when the reed (119) is in use and a load generated by fluid flow is applied to the valve closure portion (127), and the reed (119) being such that the end of the valve closure portion which is furthest away from the body portion is a straight end (303) which extends transversely to the longitudinal axis of the body portion (129).

FIG.4.



BEST AVAILABLE COPY

EP 1 002 951 A2

Description

[0001] This invention relates to a reed for use in a valve assembly. The valve assembly may be for use in a compressor.

[0002] UK Patent No. 2161583 discloses that a known reciprocating compressor has a cylinder having an inlet valve including a resilient reed which is mounted within the cylinder. The reed moves away from a valve seat to open an inlet port when the piston moves downwardly and the pressure differential between the inlet port and the interior of the cylinder reaches a certain level. The valve reed is held at a first end, which is spaced from the cylinder inlet, the gas flow forcing the reed to move and flex during intake to allow a second end of the reed to uncover the inlet port.

[0003] It has been considered undesirable for the known inlet reed to move away from the inlet port by more than a small amount, as a large degree of movement results in excess deformation fatigue and then ultimate failure of the reed. To alleviate this problem the inlet reed is conventionally provided with at least one projection at its second end, which engages with a stationary obstacle or tip-stop in the cylinder wall, the stop limiting movement of the reed to a small degree. Such a reed valve is disclosed in U.K. patent No. GB 2105821A.

[0004] It is a problem with such reeds that the flow through the inlet valve is impaired because the lift of the reed away from the inlet port is limited.

[0005] It is a further problem that the reed tip is prone to failure due to cyclical impact of the tip against the tip-stop, which impact also results in added noise.

[0006] According to the invention of UK Patent No. 2161583 there is provided a reed for use in a valve assembly, the reed being an elongate resilient reed which comprises a body portion having one end intended for fixing to a mount and another end contiguous with a valve closure portion of the reed, the reed being such that the width of the body portion tapers towards the valve closure portion so that the width of the surface of the body portion adjacent the valve closure portion is small relative to the width of the valve closure portion whereby the configuration of the reed is such as substantially to equalise the bending stress experienced by the reed along the length of the body portion when the reed is in use and a load generated by fluid flow is applied to the valve closure portion.

[0007] The reed of UK Patent No. 2161583 obviates the need for the provision of a stationary obstacle for impeding the movement of the reed in use. Also, movement of the reed is not impeded during intake of fluid to the cylinder, and thus the lift of the reed is not limited. Further, the noise generated by the interaction of the reed and a tip-stop is removed, as well as the possible fatigue of the reed caused during use. Still further, removal of the projection on the reed for tip-stop engagement results in simplification of reed production, as the reed of UK Patent No. 2161583 is of a less complex shape.

[0008] The reed of UK Patent no. 2161583 does however create a problem in that the reed is such that the end of the valve closure portion which is farthest from the body portion is a curved end. At some operating conditions, with the reed being used in a suction mode, the reed will impact on a piston in the compressor in which the reed is used. Contact between the reed and the piston can be beneficial to the reed behaviour. However, impact of the reed with the piston may damage the piston. More specifically, the impact of the reed on the piston can either locally deform the piston or cut metal from the surface of the piston. If the contact was always at the same spot on the piston, the deformation or damage would be inconsequential. However, at different operating conditions, the piston travels greater or lesser distances before the reed impacts. This means that the point of contact on the top of the piston is different.

[0009] The amount of damage to the piston that occurs on impact with the reed is a function of the pressure generated at the point of contact between the reed and the piston. This in turn is a function of the difference in velocity of the piston and the reed, the mass of the reed and the contact area. The rounded end of the reed disclosed in UK Patent No. 2161583 is such that until the reed deforms the piston, the contact area is very small. This gives high pressures at the point of contact. The high pressures in turn cause greater damage than would lower contact pressures.

[0010] It is an aim of the present invention to reduce the above mentioned problem.

[0011] Accordingly, the present invention provides a reed for use in a valve assembly, the reed being an elongate resilient reed which comprises a body portion having one end intended for fixing to a mount and another end contiguous with a valve closure portion of the reed, the reed being such that the width of the body portion tapers towards the valve closure portion so that the width of the surface of the body portion adjacent the valve closure portion is small relative to the width of the valve closure portion whereby the configuration of the reed is such as substantially to equalise the bending stress experienced by the reed along the length of the body portion when the reed is in use and a load generated by fluid flow is applied to the valve closure portion, and the reed being such that the end of the valve closure portion which is furthest away from the body portion is a straight end which extends transversely to the longitudinal axis of the body portion.

[0012] The reed of the present invention is advantageous in that the end of the valve closure portion which is furthest away from the body portion is a straight end rather than a rounded end as disclosed in UK Patent No. 2161583. The mass and stiffness of the reed and therefore the velocity of the reed can be the same as in the UK patent. However, the use of the flat end enables the contact area to be increased. This helps considera-

BEST AVAILABLE COPY

bly in preventing or reducing the above mentioned piston damage.

[0013] The reed may be one in which the body portion provides a neck adjacent the valve closure portion.

[0014] The reed may be one in which the body portion forms part of an isosceles triangle, the base of the triangle lying at the fixed end of the reed and the apex of the triangle lying at a point in the valve closure portion. Preferably, the said point in the valve closure portion is chosen to be the centre of application for the load generated by the fluid which passes through the port.

[0015] The reed may be one in which the reed comprises first and second side-by-side such body portions, each having such a tapered section which tapers away from the fixed end of the reed, each of said tapered sections being contiguous with a respective valve closure portion configured for selectively uncovering first and second inlet ports and wherein a discharge port is positioned between said tapered sections.

[0016] The present invention also provides a valve assembly having a valve and a port, the valve comprising a reed of the invention, and the valve closure portion being configured for selectively uncovering the port to allow flow of fluid therethrough. The valve assembly may be an inlet valve assembly or an outlet valve assembly.

[0017] The present invention further provides a compressor having the valve assembly.

[0018] Embodiments of the invention will now be described solely by way of example and with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view of a compressor cylinder showing a valve assembly of UK Patent No. 2161583 in the closed position;

Figure 2 is a view similar to Figure 1 showing the valve assembly in an open position;

Figure 3 is an internal plan view of the cylinder head shown in Figure 1;

Figure 4 shows an alternative reed to that used in Figure 1, the alternative reed being shown in UK Patent No. 2161583; and

Figure 5 is an internal plan view of a compressor cylinder head shown in UK Patent No. 2161583, the compressor cylinder head including a further alternative reed according to the invention of the UK Patent.

[0019] With reference to Figures 1 to 3, a valve reed is shown embodied in a compressor 1. The compressor 1 includes a piston 3 which reciprocates in a cylinder formed from a cylinder block 5 and a cylinder head 7. The cylinder head 7 is attached to the block 5 by means of mounting bolts (not shown) through a gasket 9. The cylinder head 7 is divided by a baffle 11 into an inlet side 13 and a discharge side 15.

[0020] The inlet side 13 has an inlet port 17 provided in three part-annular portions (see Figure 3). Flow through the inlet port 17 is controlled by means of a resiliently flexible reed 19. The reed is elongate and is fixed between the cylinder head 7 and block 5 at one end 21 by means of mounting pins 23. In order to accommodate differences in the width between gasket 9 and reed 19, and to ensure a firm connection between the reed 19 and the cylinder, a piece of resilient material 25 is fixed, with the reed 19, to the block 5.

[0021] The reed 19 has a tapered portion 29 extending from the fixed end 21, and a valve closure portion 27 connected to the portion 29 for covering the inlet port 17.

[0022] The valve closure portion 27 is freely movable away from the port 17 and is of annular shape, in plan, to allow intake fluid entering the cylinder to pass over the outer edge and through the centre of the valve closure portion 29.

[0023] The tapered portion 29 forms part of an isosceles triangle, with the base of the triangle being provided by the fixed end 21 and with the apex of the triangle being defined at a point within the outer circumference of valve closure portion 27, which point is chosen to be the centre of application for the load generated by the fluid which enters the cylinder through the inlet port 17 during intake. This shape of portion 29 allows the reed 19 to bend at a constant radius of curvature and flex to a far greater degree than the known inlet reed discussed above without risk of failure as will be hereinafter described. The width of the fixed end 21 is determined by the stress level which it is desired that the reed will absorb in use.

[0024] The discharge side 15 is provided with two outlet ports 31 spaced equally from the centre line of the inlet reed 19. Each discharge port 31 is provided with a discharge reed 33 of conventional construction.

[0025] In use, the inlet reed 19, which is generally planar, normally rests against the cylinder head 7 as shown in Figure 1. During a discharge stroke of the piston 3 as illustrated in this Figure, the fluid in the cylinder is pushed out through discharge ports 31, the pressure of the fluid within the cylinder serving to seal reed 19 against inlet port 17.

[0026] In Figure 2, the piston 3 is shown during an inlet stroke. Downward movement of the piston 3 causes a pressure difference across the inlet reed 19. This causes the reed 19 to flex, against its resilience, away from the port 17 into the cylinder. As the valve closure portion 27 is freely movable away from the inlet port 17 and no tip-stop is provided, movement of the reed 19 is not impeded.

[0027] The major factor which allows the removal of the tip-stop from the design will now be explained with reference to Figure 4 in which an alternative embodiment of a valve reed, generally designated 119 is shown, the reed 119 being of similar form to the reed 19, except that it has a circular valve closure portion for covering a circular inlet port.

[0028] As briefly mentioned with reference to the last

BEST AVAILABLE COPY

embodiment, the portion 129 joining the fixed end 121 to the valve closure portion 127, is of tapered shape so that the centre of application of load generated by the inlet fluid, when the valve is open, forms the apex of an isosceles triangle having its base at the fixed end 121.

[0029] This particular form of the portion 129 is chosen because it will result in the bending stress of the reed 119, when in the open position due to fluid entering the cylinder under pressure, being equalised over the whole length of the tapered portion, so that no part of this portion is stressed substantially more than any other part during flexure of the reed. This means that the reed can tolerate a large deflection without risking failure.

[0030] Using a reed of the above design, it is therefore possible to completely remove the need for a tip-stop as the reed can tolerate considerably greater bending than reeds so far proposed in the prior art acknowledged in UK Patent No. 2161583.

[0031] At high suction pressure conditions the inlet valve may open when the piston has moved only a short distance away form the head 7. The reed at this stage may contact the piston, which advantageously acts as a moving buffer to prevent excessive reed deformation at such high suction pressures.

[0032] With reference to Figure 5, a dual suction reed 219 is shown. This reed has a single fixed end 221 but has two valve closure portions 227a and 227b which cover respective inlet ports 217a and 217b. The valve closure portions 227a, 227b are connected to the fixed end 221 by means of respective tapered portions 229a, 229b, each of similar form to the reed shown in Figure 4.

[0033] This design of reed has an advantage that a discharge opening 231b can be provided between the two tapered portions 229a, 229b, in addition to discharge openings 231a and 231c, thus allowing increased flow from the cylinder, as well as providing the other advantages of the basic reed design previously mentioned.

[0034] As so far described, the various reeds and valve assemblies are as described in UK Patent No. 2161583. As will be appreciated from the description and the drawings, at some operating conditions, any given reed will impact on the piston as it opens. The contact between the reed and the piston can be beneficial to the reed behaviour, but the impact may damage the piston. The impact of the reed on the piston can either locally deform the piston, or it can cut metal from the surface of the piston. The area of contact is best appreciated from Figure 2 wherein the area of contact is indicated generally by the reference arrow 300. If the contact were always at the same point on the piston 3, the deformation or damage would be inconsequential. However, at different operating conditions, the piston 3 will have travelled a greater or lesser distance before the reed impacts and so the point of contact will be different.

[0035] The amount of damage that occurs on impact is a function of the pressure generated at the point of contact between the reed and the piston 3. This in turn is a function of the difference in velocity of the piston 3 and the reed, the mass of the reed, and the contact area. As can best be seen from Figures 4 and 5, the reeds 119 and 219 have ends which are rounded as shown. These rounded ends mean that until the reeds deform the piston 3, the contact area is very small because it is only a point contact on the rounded ends 301. This small contact area gives high pressures on the point of contact. The high pressures are thus able to cause maximum damage to the top of the piston 3.

[0036] In accordance with the present invention, the design of the reed of UK Patent No. 2161583 is altered such that the end of the valve closure portion which is furthest away from the body portion is a straight end which extends transversely to the longitudinal axis of the body portion. Apart from this difference, the reed may be of any of the designs contemplated and/or shown in the UK Patent No. 2161583.

[0037] Referring to Figures 4 and 5 of UK Patent No. 2161583, the reed in accordance with the present invention would have a straight end 302 as shown by the dotted line.

[0038] Thus the reed of the present invention may be such that the mass and stiffness of the reed and therefore its velocity may not measurably change with respect to the reed disclosed in UK Patent No. 2161583. However, the change, which is a significant change, is that the reed has a straight end, as shown by way of example as straight end 302 in Figures 4 and 5. The straight end means that the contact area of the reed with the piston is increased. This increased contact area means that damage to the top of the piston can be prevented or reduced. This in turn provides a substantial operating advantage.

[0039] Although the invention has been described with reference to an intake valve assembly, it is equally applicable for use with a discharge valve assembly. The embodiments of reed valve described above are particularly, but not exclusively, suitable for use in a refrigeration compressor.

Claims

1. A reed for use in a valve assembly, the reed being an elongate resilient reed which comprises a body portion having one end intended for fixing to a mount and another end contiguous with a valve closure portion of the reed, the reed being such that the width of the body portion tapers towards the valve closure portion so that the width of the surface of the body portion adjacent the valve closure portion is small relative to the width of the valve closure portion whereby the configuration of the reed is such as substantially to equalise the bending stress experienced by the reed along the length of the body portion when the reed is in use and a load generated by fluid flow is applied to the valve closure

portion, and the reed being such that the end of the valve closure portion which is furthest away from the body portion is a straight end which extends transversely to the longitudinal axis of the body portion.

2. A reed according to claim 1 in which the body portion provides a neck adjacent the valve closure portion.

3. A reed according to claim 1 or claim 2 in which the body portion forms part of an isosceles triangle, the base of the triangle lying at the fixed end of the reed and the apex of the triangle lying at a point in the valve closure portion.

4. A reed according to claim 3 in which said point in the valve closure portion is chosen to be the centre of application for the load generated by the fluid which passes through the port.

5. A reed according to any one of the preceding claims in which the reed comprises first and second side-by-side such body portions, each having such a tapered section which tapers away from the fixed end of the reed, each of said tapered sections being contiguous with a respective valve closure portion configured for selectively uncovering first and second inlet ports and wherein a discharge port is positioned between said tapered sections.

6. A reed according to claim 1 for use in a valve assembly, substantially as herein described with reference to the accompanying drawings.

7. A valve assembly having a valve and a port, the valve comprising a reed according to any one of the preceding claims, and the valve closure portion being configured for selectively uncovering the port to allow flow of fluid therethrough.

8. A valve assembly according to claim 7 and which is an inlet valve assembly.

9. A valve assembly according to claim 7 and which is an outlet valve assembly.

10. A compressor having a valve assembly according to any one of claims 7-9.

FIG.1.

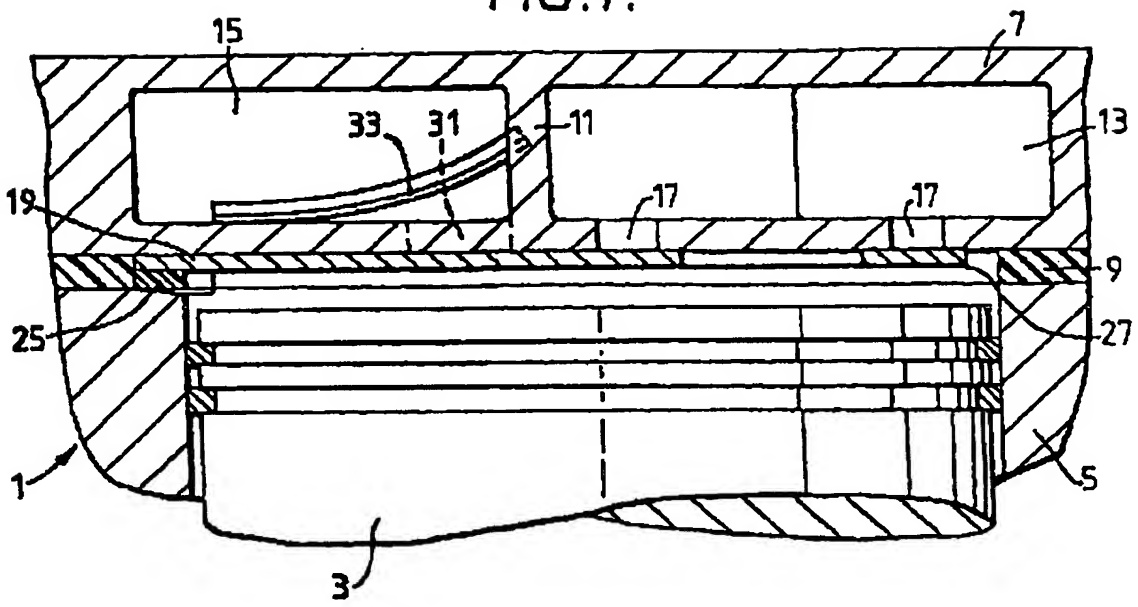

15
7
33
31
11
13
19
17
17
9
25
27
1
5
3

FIG.2.

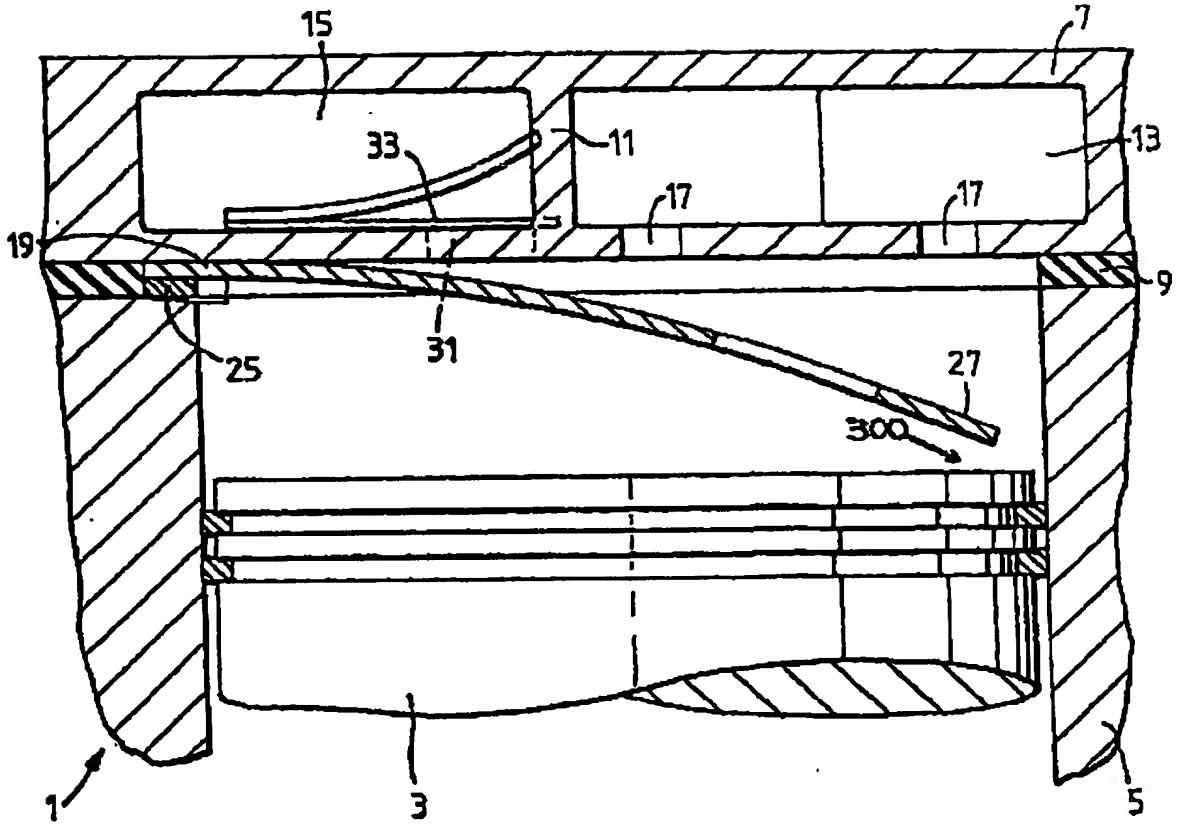

15
7
33
11
13
19
17
17
9
31
25
27
300
1
3
5

FIG. 3.

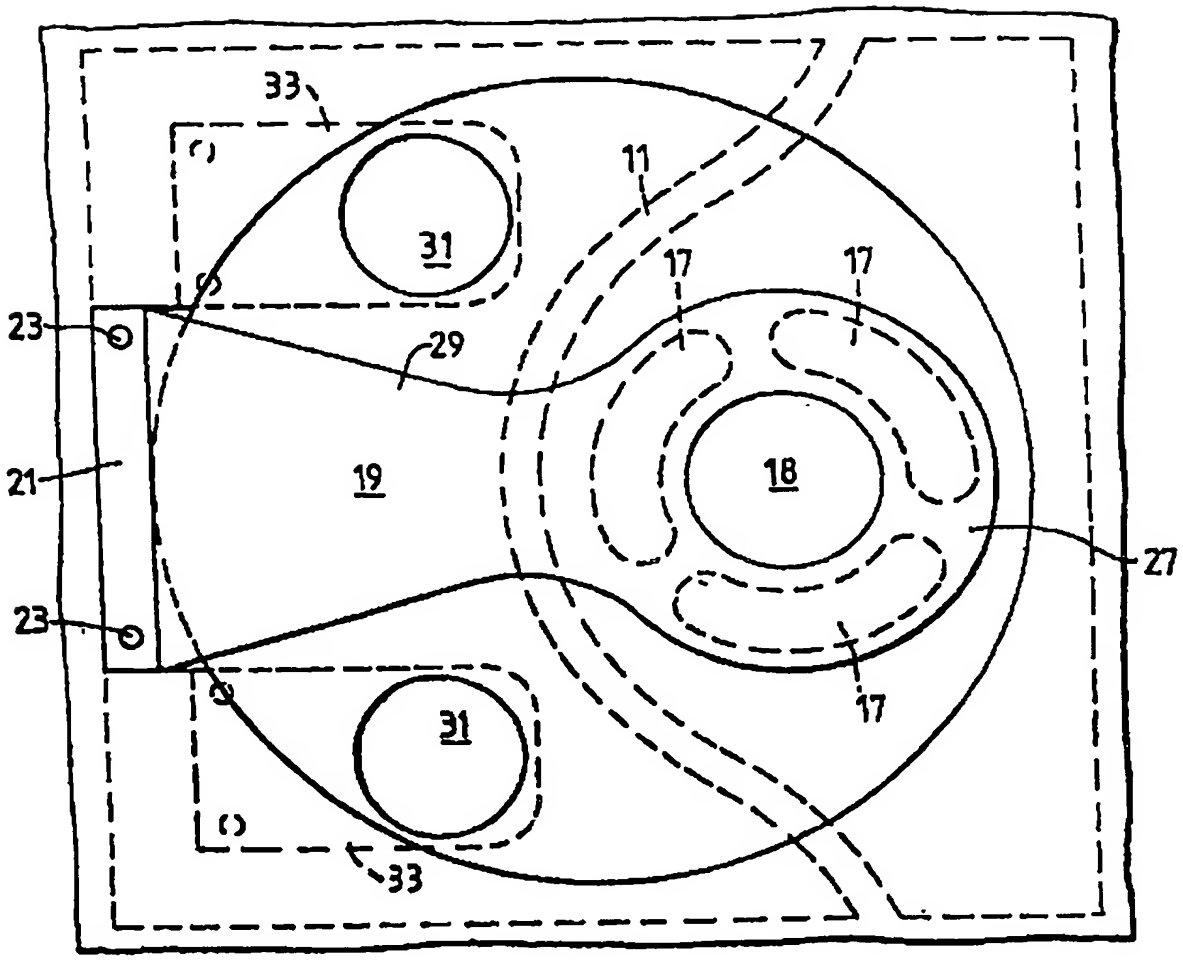


FIG. 4.

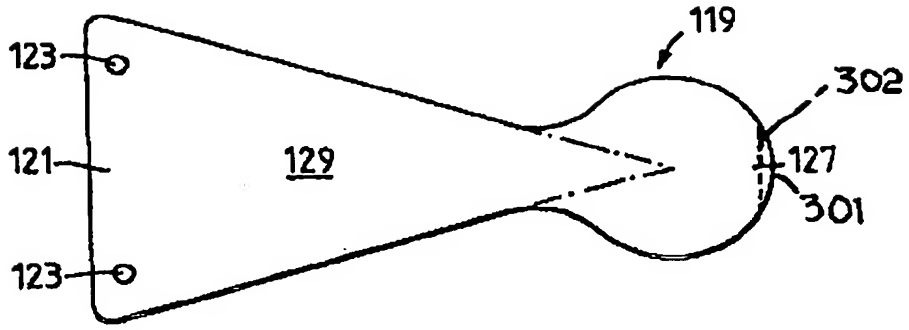
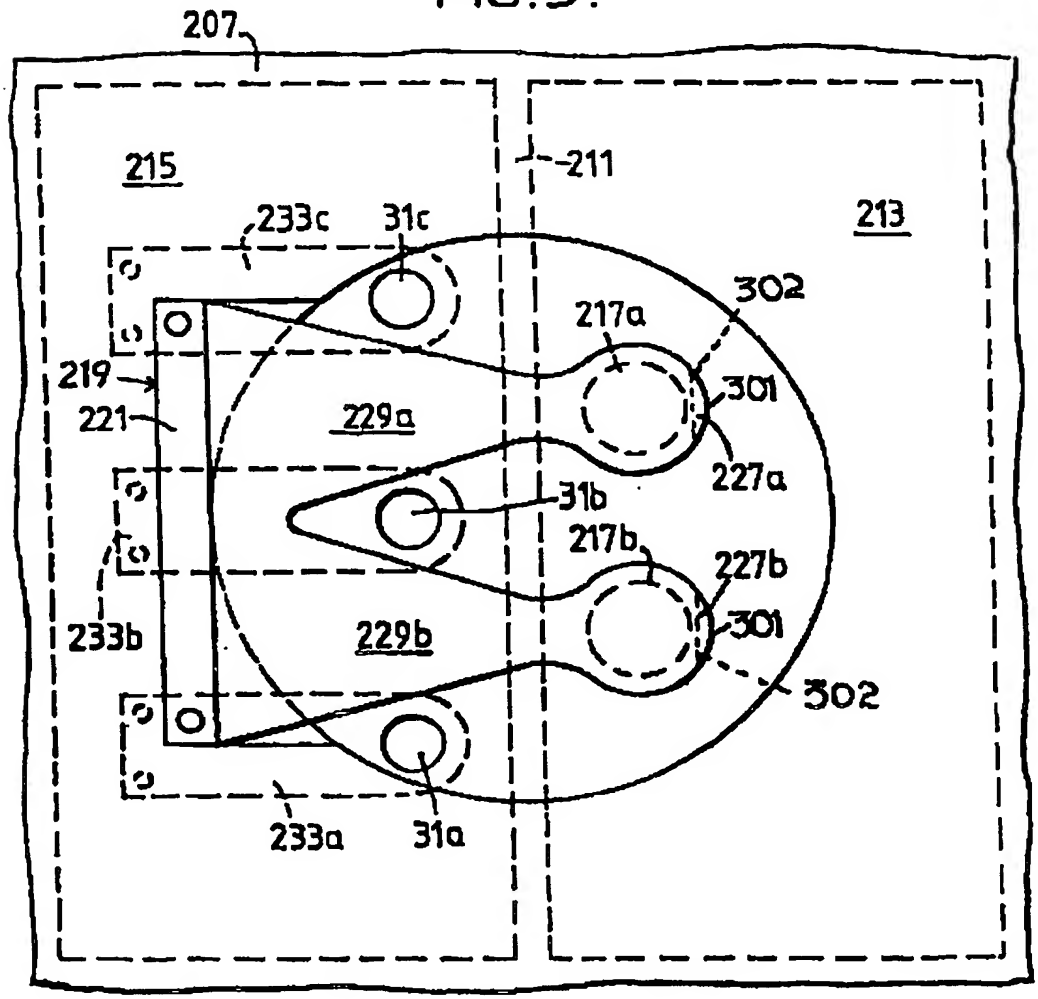

123
121
123
129
119
302
127
301

FIG. 5.


207
215
211
213
233c
31c
302
217a
219
221
301
229a
227a
31b
217b
227b
233b
229b
301
302
233a
31a

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 002 951 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
19.11.2003 Bulletin 2003/47

(43) Date of publication A2:
24.05.2000 Bulletin 2000/21

(21) Application number: **99308362.5**

(22) Date of filing: **22.10.1999**

(51) Int Cl.[7]: **F04B 39/10**, F16K 15/16

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **20.11.1998 GB 9825550**

(71) Applicant: **Arctic Circle Limited**
Hereford HR2 6JL (GB)

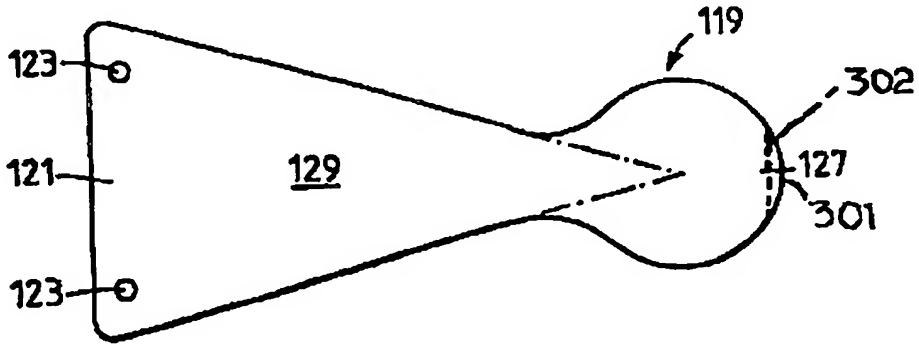
(72) Inventor: **Lawson, Stuart**
Thatcham, Berkshire RG18 3BH (GB)

(74) Representative: **Jones, Graham H.**
Graham Jones & Company
Blackheath
77 Beaconsfield Road
London SE3 7LG (GB)

(54) A reed for use in a valve assembly

(57) A reed (119) for use in a valve assembly, the reed being an elongate resilient reed (119) which comprises a body portion (129) having one end (121) intended for fixing to a mount and another end contiguous with a valve closure portion (127) of the reed (119), the reed (119) being such that the width of the body portion (129) tapers towards the valve closure portion (127) so that the width of the surface of the body portion (129) adjacent the valve closure portion (127) is small relative to the width of the valve closure portion (127) whereby the configuration of the reed (119) is such as substantially to equalise the bending stress experienced by the reed (119) along the length of the body portion (129) when the reed (119) is in use and a load generated by fluid flow is applied to the valve closure portion (127), and the reed (119) being such that the end of the valve closure portion which is furthest away from the body portion is a straight end (303) which extends transversely to the longitudinal axis of the body portion (129).

FIG. 4.



EP 1 002 951 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 8362

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	GB 860 008 A (JOHN COURTNEY FISHER) 1 February 1961 (1961-02-01) * figure 7 *	1,2,7,9, 10 3-6,8	F04B39/10 F16K15/16
D,Y	GB 2 161 583 A (PRESTCOLD LTD) 15 January 1986 (1986-01-15) * the whole document *	3-6,8	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F04B
F04C
F16K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 September 2003	Dimitroulas, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 8362

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-09-2003

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 860008	A	01-02-1961	NONE	
GB 2161583	A	15-01-1986	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82